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# THE HIGH-SEA SHRIMP RESOURCES OFF THE GUYANAS AND NORTHERN BRAZIL

by

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Rome, March 1972

## PREPARATION OF THIS DOCUMENT

This document has been based on statistical data collected by Mr. L. Butler, Fishery Statistics and Economic Data Branch, Fisheries Department, FAO, during a visit to the countries in the region in 1970. It is a first attempt at evaluating the state of the shrimp stocks in the area.

The designations employed and the presentation of the material in this document and maps do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers.

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WI/C7617

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FAO Fisheries Circular (FAO Fish.Circ.)

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## 1. INTRODUCTION

Commercial interest in the Guyanas' off-shore shrimp fishery goes as far back as 1944 when the United States and the the British West Indies conducted a joint fishing survey. It was predicted that the Guyanas' shrimp grounds would someday be big producers. Since then several exploratory cruises have been carried out. The presence of good shrimp resources (mainly pink shrimp, Penaeus brasiliensis, and brown shrimp, P. aztecus) led to the establishment of shrimp bases and of high-sea fleets. The traditional local fisheries of the various countries in that region concentrated on small inshore species, especially sea-bob (Xyphopeneus kroyeri), but pioneer operators moved in and soon the high-sea shrimp industry was well underway. Initial operations began in about 1959 in those countries closest to the fishing grounds. Plants were built in Paramaribo, Surinam; Georgetown, Guyana; and Cayenne and St. Laurent, French Guiana. Following these came those in Barbados, Port of Spain in Trinidad, and in Northern Brazil. Fleets from all these countries mingle on the fishing grounds. U.S. firms played an important part in these developments. At a later stage, Japanese fleets and more recently vessels from the Republic of Korea have appeared on the grounds; Cuban boats also participate in the fishery. Nearly the whole production is processed in the shore-based factories in the area and all these data are included in this report. The bulk of the frozen shrimp is exported to the United States. The production from the Japanese vessels goes to Japan, and French Guiana ships shrimp to France. An increasing amount of the production is used for local consumption. The large increase in the fleet as well as in the quantities of shrimp caught has naturally led to some speculation on the state of the stocks and in particular on the question whether the fishery could still expand without seriously affecting the condition of the stocks.

The present study is a result of the concern about the condition of the shrimp stocks in the area. It explores the state of the shrimp stocks in the area by examining catch statistics and to a lesser extent through investigating changes in size composition of the shrimp catches, along the same lines as followed in previous shrimp studies (FAO/UN, 1961; Boerema, 1969).

This report deals with the high-sea shrimp fishery for the large-sized shrimp species, and does not analyse the coastal, mainly traditional, fisheries for the sea-bob, a small-sized species which occurs in large quantities. Unless specifically stated, all figures given in this report refer only to the high-sea fishery. Most of the data used in this report were collected by Mr. L. Butler, Fishery Statistics and Economic Data Branch, FAO, during a visit made for this purpose to the countries in the region in 1970. The cooperation of the government officials and the fishing companies in providing catch records and other relevant information is gratefully acknowledged.

## 2. THE SHELF AND THE FISHING AREAS

The shelf area along the Atlantic coast of northeastern South America has been described as "the greatest shrimping grounds in the Western Hemisphere". Conservative estimates of the grounds between Trinidad and the mouth of the Amazon river puts the total shelf area around 75,000 square miles (Fig. 1).

The general fishing area lies roughly between the mouth of the Orinoco and the mouth of the Amazon rivers. Exploratory cruises by the U.S. research vessel OREGON reported good trawling bottom in most areas from the coast out to the 50 fathom line. The bottom generally consists of soft mud up to the 20-25 fathom contour with a mixture of mud and sand beyond this depth and up to 50 fathoms. At greater depths, often reaching the edge of the continental shelf, are rough corals and rock. Occasional patches of hard bottom do occur in the shrimping areas but most of the areas are trawlable (Bullis and Thompson, 1959).

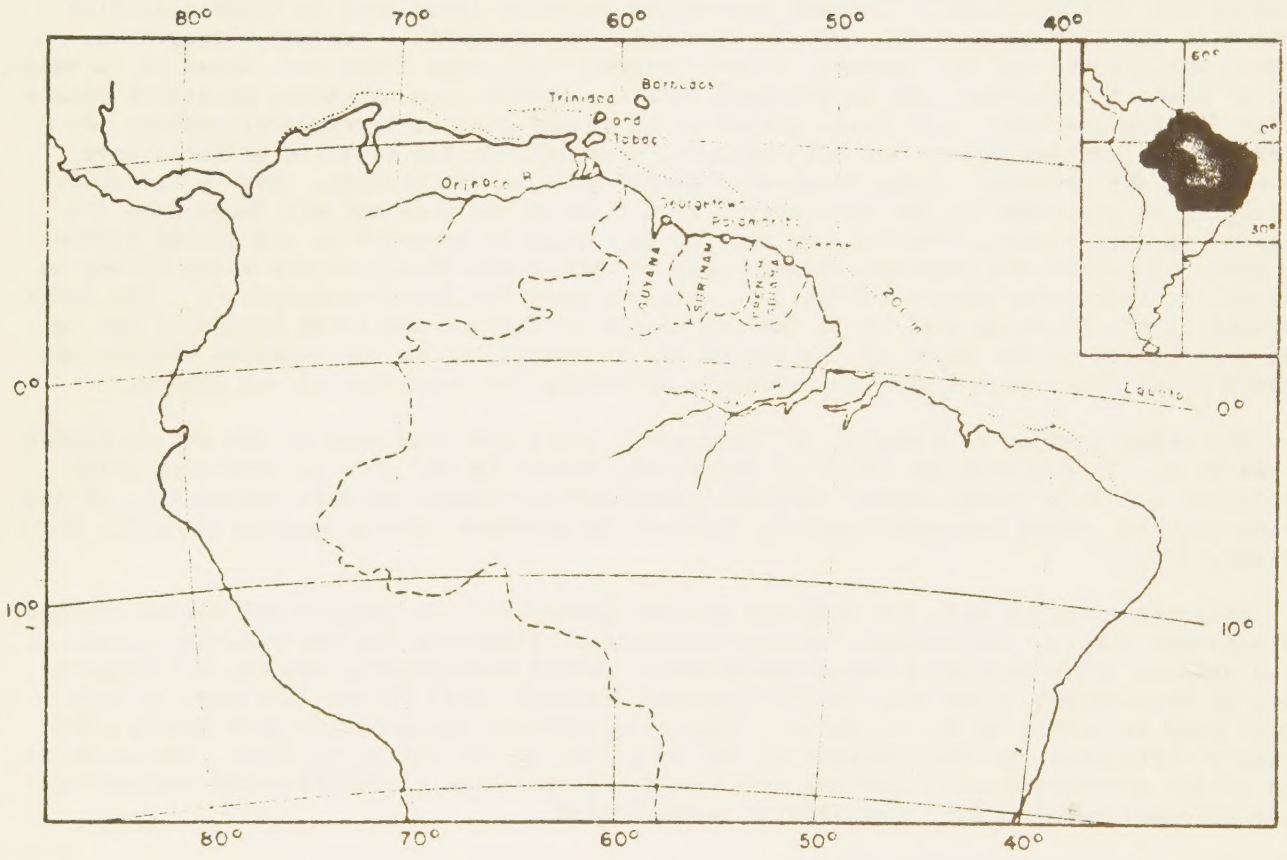


Figure 1 - Map of the area

Fishing is carried on from less than 50 to over 100 miles from shore and in depths ranging from 15 to 34 fathoms. Best catches are reported along the 30-fathom line. The shelf drops off 50 miles from the coast of Guyana, but extends further and further off-shore in a southeast direction up to the mouth of the Amazon where it is over 100 miles from land. Much of the fishing activity has been reported to be concentrated in five fairly well-defined areas (Croker, 1967):

1. The west grounds, off the coast of Guyana. These were the first to be exploited and are still popular.

2. The middle grounds, off the coast of Surinam (54°W to 56°W).

3. The east grounds, off the coast of French Guiana (52°W to 54°W).

4. The rock, in the vicinity of two small islands between 52°W and 52°15'W. This is a favourable area for boats to transfer their catches to home-bound vessels.

5. The gullies, in the Amazon area, extending from the westernmost point on the Brazilian coast to 47°30'W.

Some parts of the shelf have been exploited more intensely and for a longer time than others. The west grounds have probably been the most exploited area for shrimp. Over the years, there seems to have been a tendency for the fishery to extend southeast along the coast, down to the waters off the Brazilian coast. The recent measures taken by Brazil with respect to fishing in the waters off the Brazilian coast will substantially alter the distribution of fishing in the area. No documented information on the distribution of fishing activity on the fishing grounds was available at the time of preparing this report.

Whereas fairly heavy swells normally occur in the area, strong northeasterly winds blow continuously from January to mid-April, which limit the area of activity of the fleet.

## 3. SOURCES OF DATA

With the exception of the earlier years, data on the quantities landed were obtained from nearly all the existing shrimp companies. Where such data were not available, the total landings were estimated from country export and U.S. import figures. With a few exceptions, information from different sources showed general agreement.

For part of the history data are available on the size composition of the catches. Monthly data are also available for the more recent years (1966-1969). These were obtained from shrimp processing factories where the shrimp are normally separated into commercial size categories. The size categories were available from most companies presently operating in the area, an exception being one in Guyana, which is, in terms of production, the largest on the shelf but whose records were destroyed when its premises burned to the ground in 1969.

The number of shrimp trawlers operating on the shelf were obtained from company data, from numerous development reviews by the journal "Fish Boat", from government reports as well as from internal FAO travel reports. Information from different sources showed different figures for the number of trawlers. The growing fleet is in a constant state of flux, with new and bigger boats being added constantly and old ones being removed. Some available data refer to the beginning of the year, others to the middle. Because of the dynamic growth, it is often difficult to accurately compute the exact size of the operating fleet.

Furthermore, the pattern of fishing has not remained the same from year to year, and no data are available on the length of the trips, the time spent fishing, etc. Therefore, the measure of effort used in this report is only an approximation of the actual effort expended by the fishery. No data from Cuba have been obtained, but their omission is not believed to have affected the overall trend of the data or the conclusions.

In the previous section reference was made to the different fishing areas. No data have become available on the catches and the effort for these fishing areas separately, and hence the analysis had to be limited to a study of the fishery as a whole.

## 4. THE SHRIMP FISHERY

### 4.1 The shrimp species on the shelf

The off-shore shrimp fishery is dependent on various species. The most abundant species, and the basis of the commercial fishery, is the spotted pink shrimp, Penaeus brasiliensis. Also important is the northern pink shrimp, P. duorarum. Because of the likeness of the two species, they are not often distinguished and the proportion of the catch by species is not known. The brown shrimp, P. aztecus, is also caught in quantity (Croker, 1967). However, no data on the quantities landed by species or types of shrimp are available. 1/

The white shrimp, P. schmitti, occurs in shallow waters where trawler activity in most areas is negligible. Trinidad, however, has a special well-developed white shrimp fishery. Some 125 pirogues powered by inboard diesel engines, ranging in size between 25-35 ft, are mainly engaged in trawling for white shrimp at depths up to 5-6 fathoms in the shallow channel between Trinidad and Venezuela (Vidaeus, 1970). This fishery is not discussed in this report.

The sea-bob, Xiphopeneus kroyeri, is extremely abundant and is distributed all along the coast from Cape Hatteras, North Carolina to Southern Brazil, but up till now has not been important for the industrial fisheries discussed in this report. Compared to the other shrimp species, the sea-bob is small and is available in good quantities from 5 to 16 fathoms. The Guyanas all have coastal fisheries for sea-bobs (Rathjen and Hsu, 1970). Guyana production in 1956 was 800,000 lbs (head on), but preliminary estimates are that 4 to 5 million lbs could be harvested if a suitable market were found. The production in Surinam for the same year was in excess of 1 million lbs, and an estimated 5 to 6 million lbs might be produced annually. From 1960 to 1968 Surinam production averaged 1 to 2 million lbs per year. In French Guiana, production from 1963 to 1965 averaged about 130,000 lbs a year. In Guyana and Surinam most of the production is consumed locally. In French Guiana, however, much of the production is exported to France. The size of market shrimp varies from about 70 to 100 per pound. Rathjen and Hsu (1970) estimate that more aggressive fishing techniques would increase the production from the present 3 million lbs by a factor of ten times or more.

Various species of deep-water shrimps also occur on the shelf, but these are not yet important in the fishery. Among the numerous species inhabiting the deeper waters, three stand out as possible commercial resources: Solenocera vioscai, Plesiopenaeus edwardsianus, a large scarlet shrimp, and Hymenopenaeus robustus, the royal-red shrimp (Bullis and Thompson, 1959). Some of the present operators have already expressed interest in these commercially unexploited species (Butler, 1970, personal communication).

### 4.2 History of the off-shore shrimp fishery

As mentioned in the introduction, shrimp have been known to occur in the Guyana shelf area for many years before they were exploited commercially. The possibility of the occurrence of shrimp in commercial quantities on the shelf was pointed out as far back as

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1/ Bullis and Thompson (1959), during their exploratory surveys, found that on the grounds at a depth of 30 to 35 fathoms the catches were 98% pinks and 2% browns. In 29 fathoms, the two species were in equal weights. In 28 fathoms, the catches were exclusively browns.

1944. The development of the fishery and in particular the details of catch statistics were poorly documented up until 1964. Since then the journal "Fish Boat" has closely followed the development of the various aspects of the fishing industry there.

Oldest in years and pioneer in the shrimp industry is a plant at Paramaribo, Surinam. Established in 1956, the plant initially processed only sea-bobs. The sea-bob operation although started with much enthusiasm was reduced in favour of processing large shrimp.

The first large-scale off-shore fishing operations were launched from Guyana in 1959 by a combined operation of several smaller companies. This venture was a direct result of the positive findings of the OREGON exploratory survey along the coast of the Guyanas from north of Trinidad to off Cayenne, French Guiana. Although French Guiana had conducted several independent surveys (in 1953, 1954, 1955 and 1956) it did not join the commercial operations until 1963. Barbados, too, entered the scene in 1963. Encouraged by the success of these operations, Trinidad operating out from Port of Spain, began its large scale operations in 1966. More recently (1969) northern Brazil has also entered the off-shore shrimp fishery. Data on the development of the fleets and of the catches are given in later sections of this report.

### 4.3 Number of boats in the fleet

Table 1 shows the best available estimate of the number of boats fishing from each country, based upon the data from different sources. For Guyana, 1964, two very different figures are available, 60 and 101. The average of 81 was taken. In a similar way, the figures for French Guiana 1964 and 1967, Surinam 1963 and 1964, and Trinidad 1966 and 1967 were estimated. For the other years and countries, more consistent figures were available. Whereas for some countries and years the data may still not be precise, the general conclusion will be justified, that in all countries the fleets have in general increased, with some fluctuations in the number of boats, and the total for all countries shows a substantial and continuous increase from about 100 boats in 1961 to 400 in 1969. No detailed information is available on the average size of the boats in the whole fleet, but information from some countries suggests that the average size has increased.

Table 1 - Number of shrimp trawlers operating by country. (Estimate of the average number of boats active in each year.)

| Year | Barbados | Guyana | French Guiana (St. Laurent & Cayenne) | Surinam | Trinidad | Total |
|---|---|---|---|---|---|---|
| 1961 | - | 60 | - | 40 | - | 100 |
| 1962 | - | 72 | - | 24 | - | 96 |
| 1963 | - | 89 | 33 | 25* | - | 147 |
| 1964 | 30 | 60-101(81*) | (20*+31)51 | 25* | - | 187 |
| 1965 | 24 | 96 | (30+28)58 | 25 | - | 203 |
| 1966 | 32 | 105 | (28+39)67 | 34 | 43* | 281 |
| 1967 | 32 | 113 | (40*+49)89 | 50 | 58* | 342 |
| 1968 | 35 | 134 | (53+37)90 | 55 | 48 | 362 |
| 1969 | 36 | 142 | (65+45)110 | 51 | 63 | 402 |

* figures based on particularly scanty data

### 4.4 The catches

The best available estimates of the landings are given in Table 2 and Figure 2. The total landings increased continuously from 3.9 million lbs in 1960 to 27.3 million lbs in 1968, and declined slightly to 27.1 million lbs in 1969. This decline in the last year is due to some decline in the landings in Barbados and French Guiana, whereas in the other countries the landings continued to increase. Irregular fluctuations in the landings and dissimilarities between the trends in different countries have also occurred in previous years, but in general the trend in all countries has been an increase throughout most of the period covered, with perhaps some slackening of this increase in the most recent years.

Table 2 – Annual commercial catch of shrimp in thousands of pounds (Tails)*(not including the coastal fisheries for sea-bob and other small shrimp)

| | Barbados 1/ | Guyana 2/ | Fr. Guiana 3/ | Surinam 4/ | Trinidad 5/ | Brazil | Total |
|---|---|---|---|---|---|---|---|
| 1960 | - | 3,568 | - | 381 | - | - | 3,949 |
| 1961 | - | 3,942 | - | 447 | - | - | 4,389 |
| 1962 | - | 5,126 | - | 1,072 | - | - | 6,198 |
| 1963 | 319(Jun/Dec) | 6,040 | 2,789 | 1,387 | - | - | 10,535 |
| 1964 | 1,481 | 6,984 | 2,961 | 1,709 | - | - | 13,135 |
| 1965 | 1,891 | 8,048 | 3,960 | 2,223 | - | - | 16,122 |
| 1966 | 2,400 | 9,546 | 4,668 | 2,943 | 2,386 | - | 21,943 |
| 1967 | 2,179 | 9,036 | 7,279 | 2,536 | 3,392 | - | 24,422 |
| 1968 | 2,570 | 9,161 | 7,860 | 3,438 | 4,280 | - | 27,309 |
| 1969 | 2,069 | 10,469 | 6,577 | 3,477 | 4,469 | 74 | 27,135 |

* Data combined from national statistics, U.S.A. import figures, company data, FAO internal reports, and fishery journals.

1/ Industry commenced May 1963
2/ Operations commenced January 1959
3/ Operations commenced 1963
4/ Trawling operations for larger shrimp began October 1958
5/ Operations commenced 1965

### 4.5 Catch per boat

The average catch per boat has increased gradually, with minor fluctuations, from the early beginnings of the fishery to 1965, when a record of 79.4 thousand lbs was reached. The continued increase in the fleet size between 1965 and 1969 has coincided with a general drop in the average annual catch per boat, to a level of 67.5 thousand lbs in 1969, which was lower than in any year since 1963.

The average annual catch per boat computed separately for the different countries is shown in Table 3 and Figure 3. Whereas the highest catches for the Barbados, Guyana and Surinam fleet occurred in 1965 or 1966, those for the French Guiana and Trinidad fleet were in 1968. Also, the year to year changes for the fleets of different countries show a more irregular pattern than the total figures for all fleets together (Table 1). This may be due to factors such as differences in the average numbers of days fished, changes in fishing ground, in boat efficiency, to inaccuracies in the basic data, or to real differences in

Figure 2 - High-sea shrimp fishery off the Guyanas and northern Brazil, 1960-1969. Total catch, in million lbs, tails only

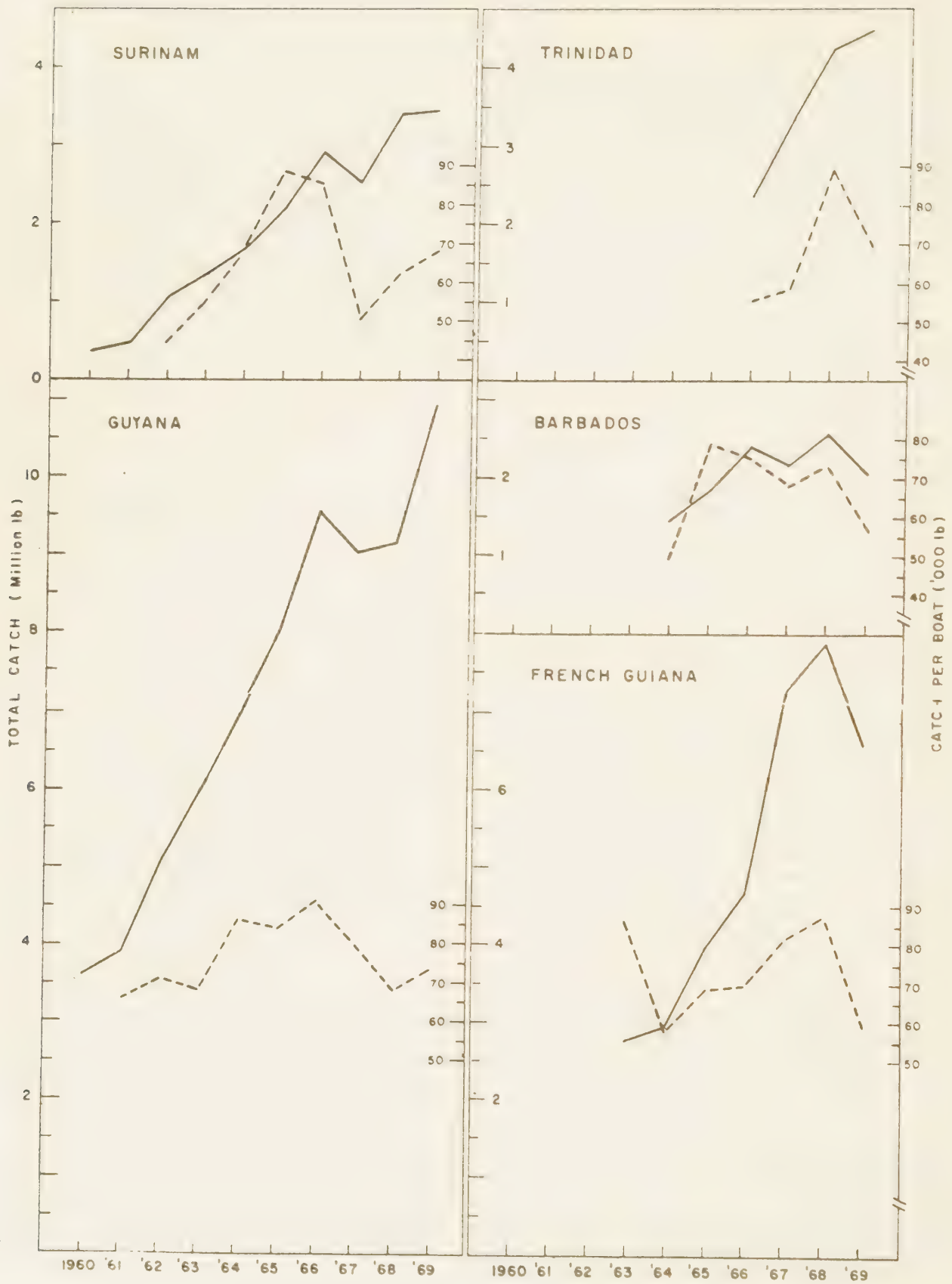


Figure 3 - Total catch (———) and catch per boat (- - -) by country, excluding Brazil

the stocks fished by those countries. More detailed information would be needed to further investigate these differences. The combined picture of the effort, total catch and catch per boat in successive years is shown in Figure 4.

Table 3 - Average annual catch per boat in pounds by country

| | Barbados | Guyana | Fr. Guiana | Surinam | Trinidad | All countries |
|---|---|---|---|---|---|---|
| 1961 | - | 65,700 | - | 11,175 | - | 44,040 |
| 1962 | - | 71,194 | - | 44,667 | - | 64,562 |
| 1963 | - | 67,865 | 84,515 | 55,480 | - | 71,667 |
| 1964 | 49,367 | 86,220 | 58,059 | 68,360 | - | 70,241 |
| 1965 | 78,792 | 83,833 | 68,276 | 88,920 | - | 79,419 |
| 1966 | 75,000 | 90,914 | 69,672 | 86,559 | 55,489 | 78,089 |
| 1967 | 68,094 | 79,965 | 81,787 | 50,720 | 58,482 | 71,409 |
| 1968 | 73,429 | 68,366 | 87,333 | 62,509 | 89,166 | 75,439 |
| 1969 | 57,472 | 73,725 | 59,791 | 68,176 | 70,904 | 67,500 |

### 4.6 Seasonal fluctuations in the catches

Figure 5 shows the average monthly catches by weight of various sizes of shrimp (average of 1967-1969 based on data from Guyana, Surinam, French Guiana and Barbados). It appears that the graphs for all except the largest shrimp (less than 26 per lb) show low catches in January and February, an increase to a peak in April, and thereafter a gradual decrease to a low level in November-December, with a slight hump in the decreasing line in about August-September. The catches of the largest shrimp fluctuate around the same level throughout the year, with rather higher catches in June-August. The data from the various countries separately show differences, but very roughly follow the same pattern, with Surinam showing the smallest differences between the monthly catches.

Because the curves for all sizes smaller than 26 per lb show peak catches in the same month, the fluctuations are due to factors such as variations in the pattern of fishing and to the general availability of the shrimp. There is no indication that the smallest shrimp appear predominantly in one season, to be followed by progressively larger shrimp in subsequent months, which would have been the case if spawning was restricted to a limited period of the year. It can, therefore, be concluded that either the different species contributing to the catches have different spawning periods, or the major species spawn throughout a substantial part of the year without a predominant spawning season.

### 4.7 Size composition of the landings

Annual figures of the total landings by size-grading are given in Annex Table 1 for the years 1967-1969. The size distribution of the total number of shrimp caught per boat per year, calculated from the data on landings by size-grading, is demonstrated in Figure 6 for the whole shelf area (based on data from Barbados, Guyana, Surinam and French Guiana) for the period 1967 to 1969 . The successive curves for 1967, 1968 and 1969 do not clearly indicate any progressive changes in the size composition of the shrimp. In particular, there has been no clear decrease in the amount of large shrimp caught, as might be expected if an increasing fishery is removing a substantial part of the stock. Table 4 shows the average size of the shrimp in the catches, by country. Whereas the average size in the catches by Surinam show a continuous decline in the period 1966 to 1969, no such trend is apparent in the catches of the other countries. The very low average size in the catches

Figure 4 - Total catch (——), catch per boat (—·—) and number of boats (– – –), per calendar year, 1960–1969

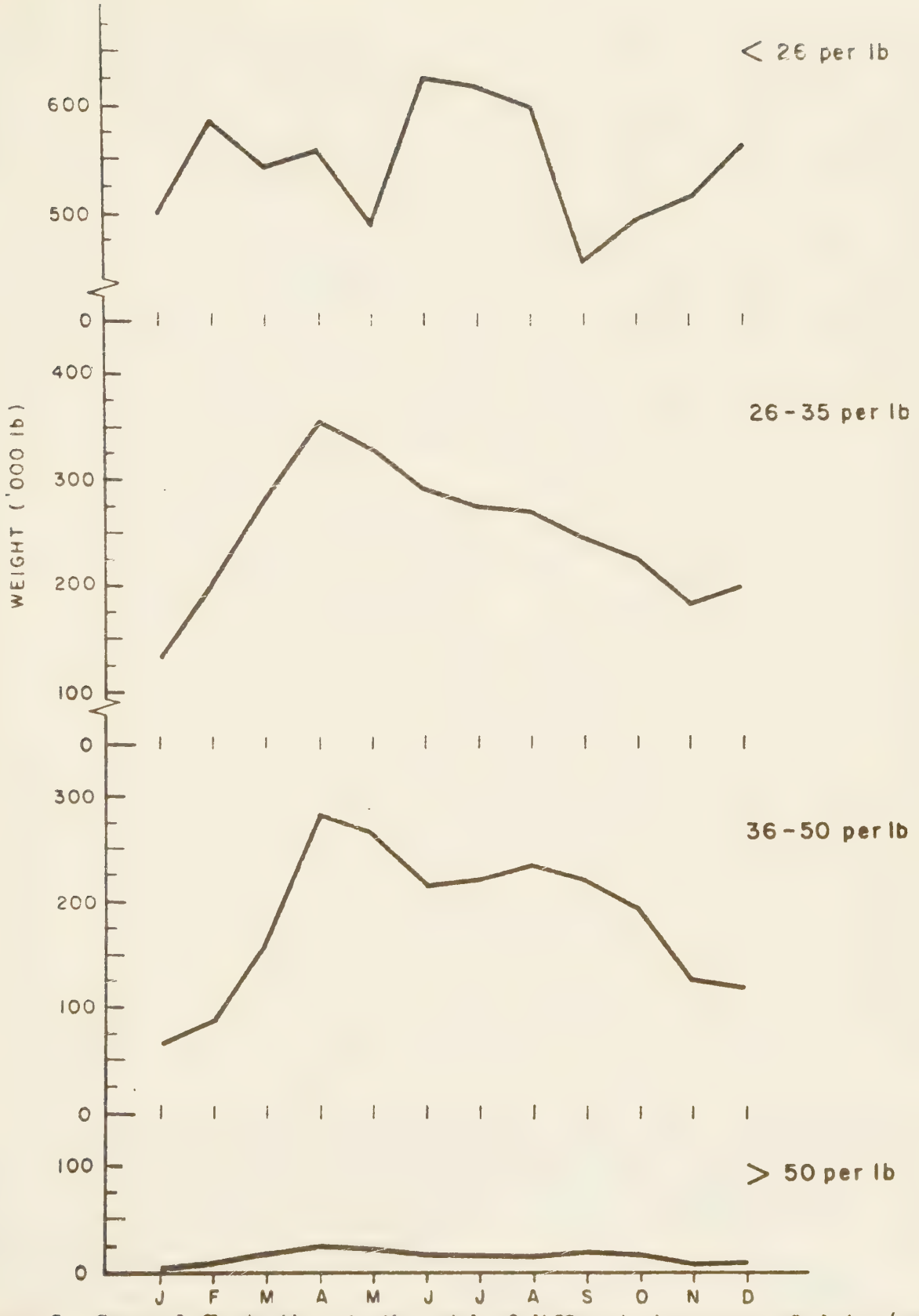


Figure 5 – Seasonal fluctuations in the catch of different size groups of shrimp (average 1967–1969)

Figure 6 - Size composition (numbers per gr. tail weight) of shrimp from the Guyana shelf area. Data from countries combined.

of Guyana in 1969 appears too abruptly to be likely to be caused by fishing, and is perhaps related to a change in fishing area and fishing tactics. (These figures refer only to part of the Guyana landings.) It should be noted, however, that the increase in fleet from 1966 to 1969 was about 20%, and that the effect of this limited increase would be likely to be small and often overshadowed by annual variations. Greater changes should be observed in a comparison with earlier years. However, no data have become available on the size distribution of the catches in earlier years, with the exception of some bi-monthly size-composition data of shrimp landed in Barbados in 1964 and 1965, collected by G. Broadhead (unpublished).

The average sizes calculated from these bi-monthly data are shown in Table 5, together with comparable data of the average size of the landings in Barbados in 1967-1969. The average size in the 1967-1969 catches is well below that in 1964-1965 for the first half of the year (especially well below 1964 figures), but in the second half of the year the figures for 1967-1969 are at about the same level as in 1964-1965, or sometimes even higher. Judging from the straight averages of the 1964 and 1965 figures, the average size of the shrimp in the annual landings in Barbados in 1967-1969 is well below that in 1964-1965. The fact that the trends in the average size of the shrimp in the Barbados catches in the first half of the year between 1964 and 1969 is different from that of the second half, may well indicate a change in fishing area or of fishing tactics.

Table 4 - Average weight per shrimp in grams, by country, 1966-1969

| Country | 1966 | 1967 | 1968 | 1969 |
|---|---|---|---|---|
| Barbados | ... | 17.50 | 18.32 | 18.12 |
| French Guiana | 17.03 | 16.26 | 17.27 | 17.05 |
| Guyana | 17.24 | 18.43 | 17.42 | 13.65 |
| Surinam | 19.51 | 19.09 | 18.75 | 17.59 |

Table 5 - Average weight per shrimp in grams, landed in Barbados, 1964-1969

| | Jan./Feb. | March/April | May/June | July/Aug. | Sept./Oct. | Nov./Dec. |
|---|---|---|---|---|---|---|
| 1964 | 28.1 | 25.7 | 21.2 | 19.6 | 17.9 | 19.8 |
| 1965 | 23.7 | 21.8 | 17.4 | 17.4 | 17.6 | - |
| 1967 | 18.4 | 15.5 | 17.2 | 18.7 | 17.3 | 21.6 |
| 1968 | 21.8 | 17.1 | 17.5 | 18.8 | 18.1 | 18.6 |
| 1969 | 18.4 | 16.7 | 17.7 | 18.0 | 19.3 | 19.5 |

## 5. DISCUSSION

When a fishery is newly developing, the increasing experience of the skippers, knowledge of the fishing grounds, improvements and adjustments in gear, etc., usually result in increasing catches per boat. When fishing increases further to a level at which it takes a significant part of the stock, the catches per boat start to decline, whereas the total catches of the whole fleet continue to increase, although at a diminishing rate. At still higher levels of fishing, the further decrease in the catch per boat may result in a decrease in the total catch.

The increase in the catch per boat in the earlier years of the industry, and its subsequent decrease when the fishery developed further, is also observed in the present data, as has been mentioned in Section 4.5. In order to obtain a better picture of the relation between fishing effort and catch, the total catch and the catch per boat have been plotted

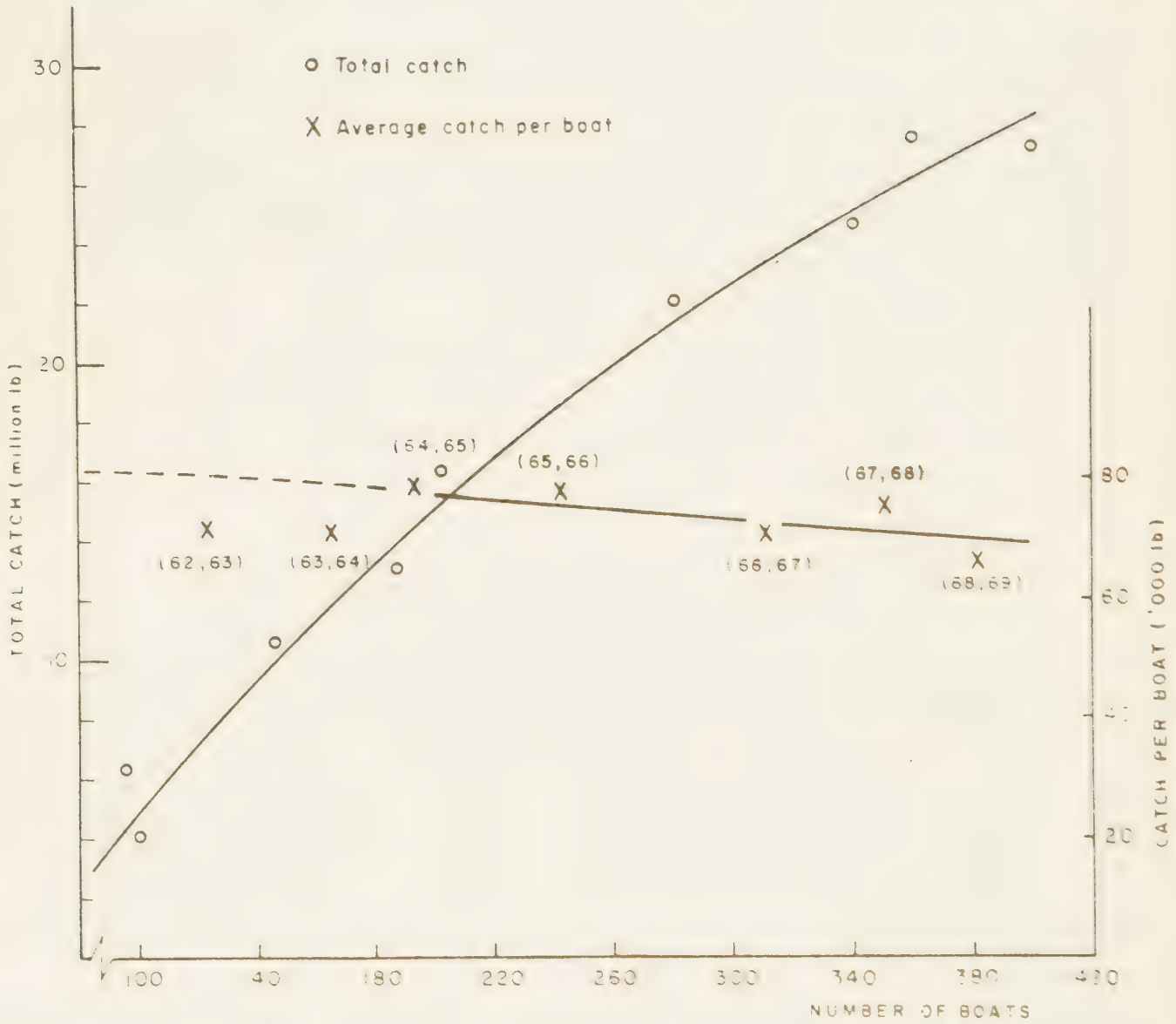


Figure 7 – Shrimp catch per year at different levels of fleet size

against the total number of boats in Figure 7. It has been mentioned in Section 4.6, that shrimp larger than 26 per lb, which form a substantial part of the catch, are caught throughout the year, and the year class to which this shrimp belongs will, therefore, already have been subject to fishing in the previous year. In order to allow for this, the catch in each year has been plotted against the average number of boats in that and the previous year. The graph shows a moderate but fairly consistent decline in the catch per boat once the fleet size had reached a level of about 200 boats, and a continuous but gradually diminishing increase in the total catch with increasing fleet size.

In addition to affecting the catch per boat, a relatively high level of fishing would also result in a decrease in the average size of the shrimp caught, and it has been shown in Section 4.7 that such a decrease has indeed been observed in the figures of some countries, although not in those of other countries. The decrease was particularly evident if the data from later years are compared with some very limited data from 1964 to 1965, when the fleet size was about half that of 1969. Part of the variations may in fact be due to inaccuracies of the data, but part may also be real and due to differences in fishing area, fishing tactics, boat development, etc. Notwithstanding these limitations and inconsistencies in the data between countries, the data suggest that indeed the present fleet size exerts a significant effect on the stocks, which means that it catches at least a fair part of the shrimp stocks.

If the distribution of the fleet among the fishing grounds has remained more or less the same in the years since about 1965, the curves of Figure 7 would indicate that a moderate further increase in the fleet would still give a higher catch, although the catch per boat per year would on the average decrease below its present level. If, however, the expansion of the fleet has been accompanied by an exploitation of new fishing grounds, e.g. those farther away along the Brazilian coast, then part of the observed increase in catch would have been due to the exploitation of virgin grounds, in which case the possibility for further increase of the total catch might well depend on tapping as yet unfished resources. An indication of a change in fishing area was mentioned in Section 2 and in the discussion of size composition of the Barbados catches in Section 4.7.

Whereas these conclusions refer to the exploited area as a whole, it is possible that the effects of fishing on some of the individual fishing grounds have already reached more substantial levels. It would, in particular, seem likely that the fishing areas relatively close to the ports of landing are more heavily exploited than those farther away. The closer grounds may, therefore, already have been fished at a level fairly close to that giving the optimum yield. As was mentioned in Section 2, however, no data by fishing area have become available, and thus it is not possible to assess the potential yield and the state of the fishery for each of the sub-areas within the total area covered by this fishery. Also, no information is available on the existance of one or more separate "stocks" within each of the major species in the area.

The recent measures taken by Brazil with respect to fishing off its coast is greatly affecting the amount and distribution of fishing in the area. The analysis of these changes, and of the resulting changes in the catches, will provide further important information for evaluating the potential yield and the optimum level of fishing of the high-sea shrimp fishery in this area.

## 6. SUGGESTIONS FOR FUTURE RESEARCH

The above analysis has been based on rather general data, which in several cases contained uncertainties and inaccuracies, both with respect to fleet size as well as to quantities caught, in particular for the earlier years of the fishery. Data on size compositions were available only for the later years, and no quantitative information was available on the species composition of the catches nor on the catches and effort by area.

More definite conclusions will be possible when data comparable to those used in this report become available for the current and future years. The analysis can be further

improved if inaccuracies and gaps in the present data can be corrected and amended.

It would be of particular importance for future analysis if data could be collected on the amount of fishing (number of days fished per boat) and the catches for each major fishing area separately. In addition, a sampling programme to determine the species composition and the size composition of the landings for each major fishing area would be of great value. Furthermore, collection of general knowledge existing in the industry with respect to extent and changes in fishing area and fishing practice in the past would allow a better understanding of the observed changes and would add to the value of the future research.

## 7. SUMMARY AND CONCLUSIONS

7.1 The off-shore shrimp fleet fishing on the shelf off the Guyanas and Northern Brazil has expanded from about 100 vessels in 1961 to about 400 in 1969.

7.2 The total catch of shrimp landed has increased from about 4 million lbs (tails) in 1960 to about 27 million in 1968 and 1969.

7.3 The average catch per boat per year increased from 44.6 thousand lbs in 1961 to 79.4 thousand lbs in 1965 and thereafter decreased to 67.5 thousand lbs in 1969.

7.4 The catch consists of a mixture of at least three different species (*Penaeus brasiliensis*, *P. duorarum* and *P. aztecus*), but no data are available on the quantities landed by species. Recruitment of the shrimp into the fishery appears to occur throughout the year.

7.5 The average size of shrimp in the catches showed a decline in some countries during the period 1964 (1966)-1969, but no discernable change during the period 1966-1969 was apparent in the other countries.

7.6 The data suggest that the fishery has reached a level in 1969 at which it catches a fair part of the stocks. A limited further increase in fishing will probably lead to a further increase in total catch, but to a further decline in the catch per boat of the present size and efficiency. How far the present level of exploitation is below that giving the optimum sustainable yield could not be determined because of the lack of information on catch and fishing effort by area and on the extension of the total area of fishing in the course of the years. The statements refer to the area as a whole, the individual fishing grounds may be more or less heavily exploited than the results indicate for the total area.

7.7 Suggestions for future research include the collection of catch and effort data and of species and size composition of the catches for the major fishing grounds separately.

Annex Table 1 - Shrimp - Landings in pounds by size category for part of the total landings for which breakdown is available

| | 1966 | 1967 | 1968 | 1969 |
|---|---|---|---|---|
| | ( . . . . . lbs . . . . . ) | | | |
| < 10 | 57,536 | 45,775 | 127,860 | 71,306 |
| < 12 | 20,277 | 47,862 | 90,383 | 121,570 |
| < 15 | 292,501 | 633,924 | 705,960 | 292,065 |
| 10 - 15 | 475,840 | 786,527 | 1,069,319 | 868,818 |
| 16 - 20 | 1,925,516 | 2,528,857 | 3,588,686 | 2,783,452 |
| 21 - 25 | 1,740,345 | 2,752,852 | 2,617,226 | 2,322,859 |
| 26 - 30 | 1,102,935 | 1,793,944 | 2,015,751 | 1,705,131 |
| 31 - 35 | 638,675 | 1,177,073 | 1,555,673 | 1,564,708 |
| 36 - 40 | 851,574 | 1,417,111 | 1,277,966 | 1,204,024 |
| 41 - 50 | 446,614 | 1,228,261 | 1,076,460 | 1,048,794 |
| 51 - 60 | 86,325 | 93,844 | 225,836 | 231,446 |
| > 60 | 7,363 | 5,781 | 298 | 4,943 |
| Unsorted | 363,487 | 678,196 | 1,010,292 | 627,359 |
| TOTAL | 8,008,988 | 13,190,007 | 15,361,710 | 12,846,475 |
| TOTAL LANDINGS FROM ALL COMPANIES | 21,943,000 | 24,422,000 | 27,309,000 | 27,135,000 |

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